HAB Bulletin Guide – An Overview

Blooms of toxic dinoflagellate *Karenia brevis* are commonly known as red tides or harmful algal blooms. These blooms are responsible for serious public health problems and shellfish harvesting closures in the Gulf of Mexico every year. The National Oceanic and Atmospheric Administration (NOAA) provides the Harmful Algal Bloom (HAB) Bulletin to help coastal resource managers decide where to focus their sampling efforts and prepare for these blooms.

The HAB Bulletin uses satellite imagery, field observations, and buoy data to provide information on the location, extent, and potential for development or movement of *Karenia brevis* blooms in the Gulf of Mexico. The information is sent twice a week via e-mail to registered users with natural resource management responsibilities. Seventy-two hours after the bulletin has been issued, it is posted to the CoastWatch Harmful Algal Bloom Bulletin Web site for public access.

Each bulletin includes satellite image interpretation, analysis of past and forecasted wind data from NOAA's National Weather Service and National Data Buoy Center, and field data regarding *Karenia brevis* cell concentrations from the state of Florida.

The bulletin's developers welcome user feedback to improve the bulletin and the HAB forecasting system. Send your comments via e-mail to *hab@noaa.gov.*

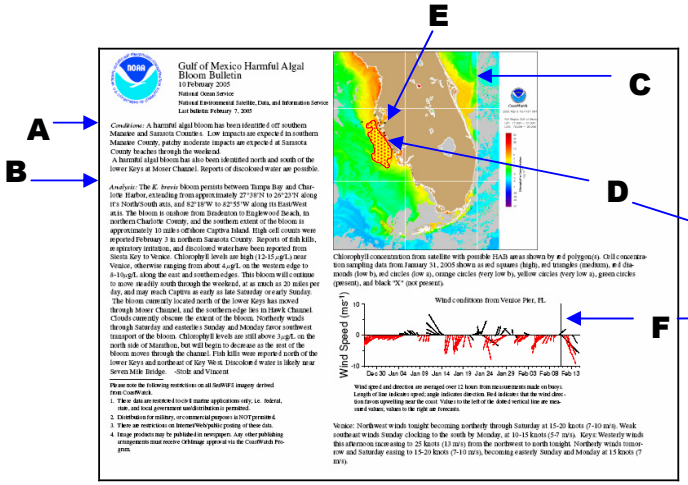
Understanding and Interpreting the Bulletin

The different sections of the bulletin are labeled and explained in the text below.

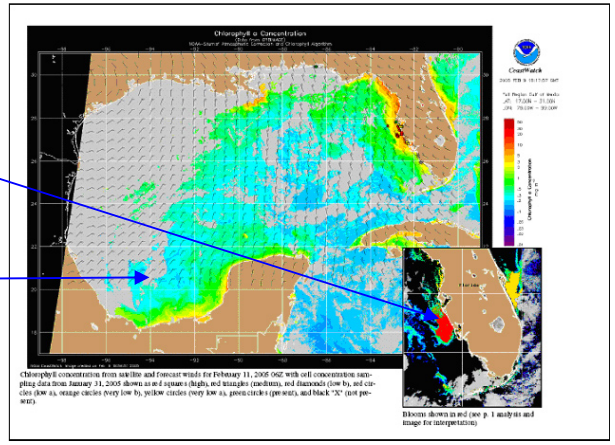
(A) *Conditions report*
The conditions report contains general information on bloom location and expected coastal impacts based on bloom concentration and prevailing winds (Kirkpatrick and others, 2004). This information was developed with state and local agencies, tourist boards, and citizen groups to provide accurate information to a non-technical audience. The report is released to the public on the *HAB Forecasting System Web site,* along with additional information about cell concentration categories and potential impacts, and a "frequently asked questions" section.

(B) *Analysis*
The analysis includes a synthesis of the supporting data such as chlorophyll concentrations, including anomalous chlorophyll concentrations and wind speed and direction, to help managers decide where to take their next samples and how to prepare for these blooms. The analysis also identifies existing HABs and their predicted location, as well as any reported impacts on humans, marine mammals, and fish.

(C) *Ocean color imagery*
Daily ocean color imagery from the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) is processed to chlorophyll by NOAA CoastWatch. This chlorophyll imagery is provided in the HAB Bulletin. A detailed image of the region of interest is

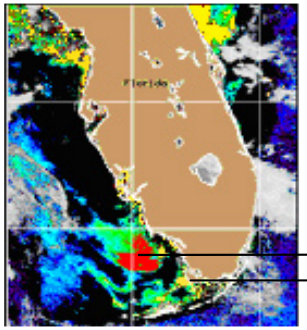


Front Side of Bulletin



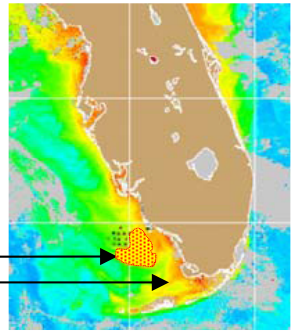
Back Side of Bulletin

Anomaly Image



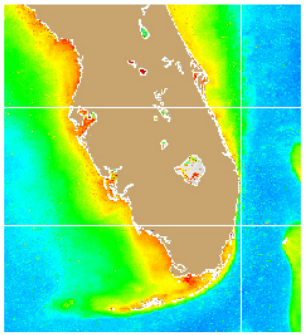
Example of a chlorophyll anomaly image (back page of bulletin). The yellow colored areas represent regions that have experienced a rapid increase in chlorophyll and have not been identified as harmful. Red colored areas are regions of high chlorophyll that have been verified as K. brevis blooms

Daily Chlorophyll Image



Example of a daily chlorophyll image with marked sampling sites (front page of bulletin). The red polygons are chlorophyll anomaly areas that have been verified as containing *K. brevis* blooms.

Average Image



This image is the average chlorophyll concentration for the 60 days prior to the image on the left. This image is not provided on the bulletin.

The top arrow indicates an anomaly area (left image) that has been verified as a *K. brevis* bloom (middle image), shown as a red polygon.

The bottom arrow indicates a region of high chlorophyll associated with a non-harmful *Rhizosolenia* bloom. A red polygon is not shown on the daily chlorophyll image because it is not a harmful algal bloom.

shown on the front, and an image of the entire Gulf of Mexico is shown on the back of the bulletin. Chlorophyll concentration units are reported in micrograms (µg) per liter (L). The legend shows the chlorophyll concentration that corresponds to the coloration on the satellite image (ranging between 0.01 and 50 µg/L). Red and orange areas on the satellite image indicate high chlorophyll concentrations, and blue and purple areas indicate very low chlorophyll concentrations.

While *Karenia* blooms can cause high concentrations of chlorophyll, many non-harmful algae routinely produce high concentrations, so chlorophyll is not a reliable indicator of the presence of a red tide. For that reason, polygons of confirmed or probable *Karenia* blooms are overlain on the chlorophyll image. These are derived from the anomaly images (see next section), but they are selected by the analysts. The polygon outlines the area most likely to contain the *K. brevis* bloom; however, the extent of a harmful bloom can go beyond the polygon, and in some cases, part of the enclosed area may include a bloom of a harmless species.

(D) *Chlorophyll anomaly*

The chlorophyll anomalies show areas where the daily chlorophyll concentration is significantly higher than the average for a particular region. Imagery from the previous 60 days is used to calculate a running mean for comparison to the current daily image (Stumpf and others, 2003). A *Karenia brevis* bloom grows fairly rapidly during the fall and often occurs solely, without the presence of other algae species (monospecific); an anomaly of 1 µg/L can indicate a *K. brevis* bloom.

Anomalies can also indicate blooms of non-harmful species. The anomaly image represents areas that have undergone a fairly rapid change in chlorophyll, usually due to high growth, aggregation, or resuspension. The anomaly for the day is included as an inset on the back page and is colored black if there is no significant change, green if significant change is detected, yellow for greater change, and red for a verified bloom. If monitoring programs (such as the Mote Marine Lab, Florida Fish and Wildlife Research Institute, or others) verify an anomaly area as containing *Karenia* species, then the area is "flagged" as a red tide and will appear as a polygon on the front page chlorophyll image. An area is not identified as a red tide unless field samples taken by the state confirm that harmful algae are present.

(E) *Position and concentration of the present bloom*

Cell concentration field data provided by monitoring agencies in the Gulf states are plotted on the chlorophyll image on the front page of the bulletin. Cell concentration sampling data are provided as they become available. There is often a several-day delay between the date of sampling and the date the information becomes available because of the need to verify algal species using microscopy. Cell concentrations are classified by the Florida Marine Research Institute (FMRI) scheme as shown in table 1 (below).

Table 1.
Cell Concentrations and Associated Cell Count Values

NP	Not present	X
Present	less than 1,000 cells per liter	●
Very low a	1,000 to 5,000 cells per liter	●
Very low b	5,000 to 10,000 cells per liter	●
Low a	10,000 to 50,000 cells per liter	●
Low b	50,000 to 100,000 cells per liter	◆
Medium	100,000 to 1,000,000 cells per liter	▲
High	greater than 1,000,000 cells per liter	■

(F) *Wind data*

Measured and forecasted wind speed and direction for the area of interest are used to estimate movement of blooms and are provided on the front page of the bulletin. The windplot diagram shows wind speed (reported in meters per second) and direction averaged over 12 hours from measurements made at station buoys. These measurements are reported to the NOAA National Data Buoy Center (NDBC). Measured values for the past thirty days are shown to the left of the dotted vertical line, which represents the present time, and forecasted values for the next five days are to the right of the dotted vertical line. The length of the vector represents wind speed, and the angle indicates the direction. For each vector, the tail is the end that starts at the "0" reference line; the arrow at the head of the vector indicates the direction the wind is blowing. Red indicates that the wind direction favors upwelling near the coast, which can be an indicator of bloom initiation.

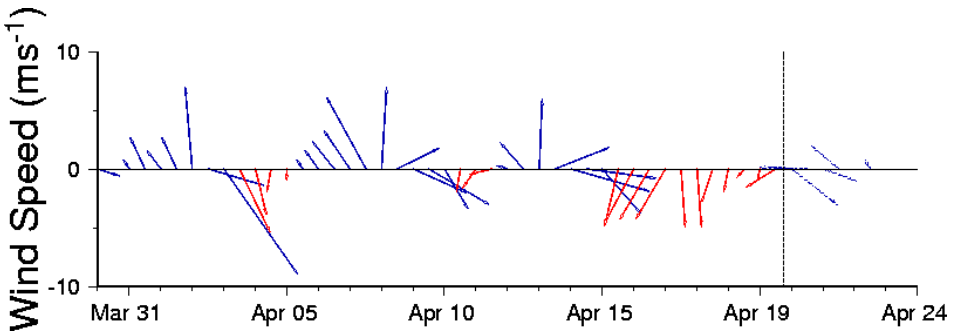
Example Windplot Diagram.
Upwelling-favorable winds are marked in red.

A 24-hour forecast of wind direction and speed as predicted by the National Weather Service's Environmental Modeling Center is plotted over the image of the Gulf of Mexico on the back page of the bulletin. The forecast is from the North American Mesoscale (NAM) computer model. In this diagram, wind speed and direction are depicted as barbs, which point in the direction the wind originates from (see figure below). The barb pennant symbol represents the wind speed.

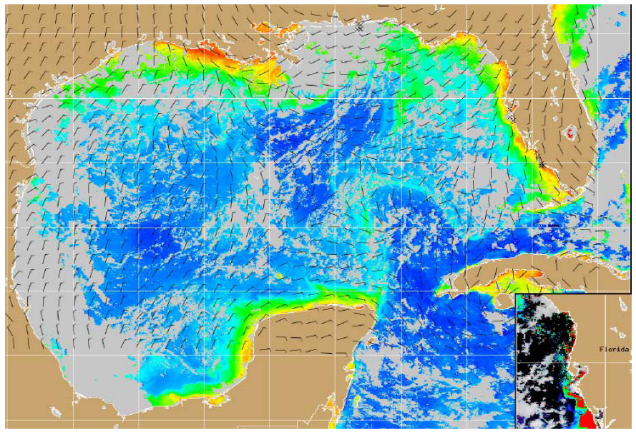
Citations

Kirkpatrick, B., L.E. Fleming, D. Squicciarini, L.C. Backer, R. Clark, W. Abraham, J. Benson, Y.S. Cheng, D. Johnson, R. Pierce, J. Zaias, G.D. Bossart, and D.G. Baden. 2004. "Literature Review of Florida Red Tide: Implications for Human Health Effects." *Harmful Algae*. Volume 3. Pages 99 to 115.

Stumpf, R.P., M.E. Culver, P.A. Tester, M. Tomlinson, G.J. Kirkpatrick, B.A. Pederson, E. Truby, V. Ransibrahmanukul, and M. Soracco. 2003. "Monitoring Karenia brevis Blooms in the Gulf of Mexico Using Satellite Ocean Color Imagery and Other Data." *Harmful Algae*. Volume 2. Pages 147 to 160.

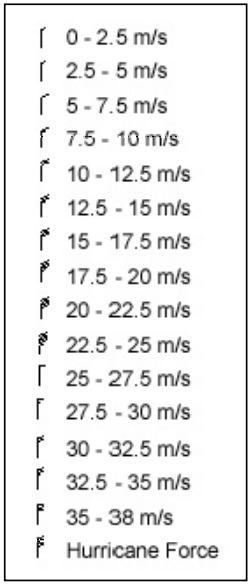


Example Windplot Diagram. Upwelling-favorable winds are marked in red.



Example Forecasted Wind Speed and Direction for the Gulf of Mexico

This barb indicates 5 to 7.5 meters per second (or 11.2 to 16.8 miles/hr) winds from the northeast



Barb Pennant Symbol and Corresponding Wind Speed